TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Metals, Pathogens and Turbidity

In the Hurricane Creek Watershed

For Segments

Hurricane Creek Watershed

Aluminum

Pathogens

Turbidity

Iron

Little Hurricane Creek Watershed

Aluminum, Copper

Pathogens

Iron

North Fork Hurricane Creek Watershed

Aluminum

United States Environmental Protection Agency

Region 4 serving the southeast

Summary Page

TOTAL MAXIMUM DAILY LOAD (TMDL)

Metals, Pathogens and Turbidity

In the Hurricane Creek Watershed

Under the authority of Section 303(d) of the Clean Water Act, 33 U.S.C. 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the U.S. Environmental Protection Agency is hereby proposing TMDLs for metals, pathogens and turbidity for listed waters in the Hurricane Creek Watershed in Alabama. The listed waterbodies in the watershed are:

Hurricane Creek

Little Hurricane Creek

North Fork Hurricane Creek.

The calculated allowable loads of metals, pathogens and turbidity that may come into the identified segments of the Hurricane Creek Watershed without exceeding the applicable water quality standards are provided below:

North Fork Hurricane Creek Watershed	Aluminum (pounds/year)
Baseline	76,140
TMDL	19,000
Percent Reduction	75%

Little Hurricane Creek Watershed	Aluminum (pounds/yr.)	Arsenic (pounds/yr.)	Copper (pounds/yr.)	Total Chromium (pounds/yr.)	Iron (pounds/ yr.)	Fecal Coliform Load (counts/100 ml * flow)
Baseline	24,990	141	154	153	2120	8,960,000
TMDL	10,000	NA	62	NA	1480	1,800,000
Percent Reduction	60	NA	60	NA	30	80

Little Hurricane Creek Watershed	Aluminum (pounds/yr.)	TSS (pounds/yr.)	Iron (pounds/yr.)	Fecal Coliform Load (counts/100 ml * flow)
Baseline	319,362	9,550	240,000	1,030,000,000
TMDL	9,000	6,880	204,000	300,000,000
Percent Reduction	60	30	15	70

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1 Introduction

Section 303(d) of the Clean Water Act (CWA) as Amended by the Water Quality Act of 1987, Public Law 100-4, and the United States Environmental Protection Agency's (USEPA/EPA) Water Quality Planning and Management Regulations [Title 40 of the Code of Federal Regulation (40 CFR), Part 130] require each State to identify those waters within its boundaries not meeting water quality standards applicable to the water's designated uses. Total maximum daily loads (TMDLs) for all pollutants violating or causing violation of applicable water quality standards are established for each identified water. Such loads are established at levels necessary to meet the applicable water quality standards with consideration given to seasonal variations and margins of safety. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality-based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

Alabama's 1998 Section 303(d) list identified three waterbodies in the Hurricane Creek watershed as not supporting their designated uses due to metals, pathogen, and/or turbidity impairments.

This TMDL is being developed pursuant to the 1998 Alabama 303(d) list and the Consent Decree and Settlement Agreement in the Alabama TMDL lawsuit that requires TMDLs to be developed for all waters on the State's 303(d) List according to certain conditions prescribed in the Consent Decree and Settlement Agreement.

Hurricane Creek is located entirely in Tuscaloosa County in north-central Alabama. The creek's approximate 116-square mile (74,329 acre) drainage area is represented by the Hurricane Creek watershed (See Figure 1). The headwaters of the Hurricane Creek watershed form in Tuscaloosa County and flow in a westerly direction for approximately 31 miles until the stream's confluence with the Black Warrior River north of the City of Tuscaloosa. The major tributaries to the main stem are the North Fork Hurricane Creek, Little Hurricane Creek, Kepple Creek, and Cottondale Creek.

The watershed is located within the outcrop of the Pottsville Formation of Pennsylvanian age, which contains coal seams that have been extensively mined, producing surface water pollution and acid mine drainage problems (Geological Survey of Alabama, 1999). The watershed is dominated by forested lands and areas disturbed by coal-mining activities (USEPA, 2000). Mined areas include active and inactive facilities as well as abandoned sites. Other land uses in the watershed include silviculture, and to a lesser extent, agriculture, industrial development, and residential development. The watershed's population is widely distributed throughout small towns and rural communities (Environmental Health Department, personal communication 2001); the largest towns in the watershed include Vance, Brookwood, and the outskirts of the City of Tuscaloosa.

2 Problem Definition

Three waterbodies in the Hurricane Creek watershed have been included on Alabama's 1998 303(d) list due to metals, pathogen, and/or turbidity impairments (See Table 1). These listed waterbodies include the entire main-stem of Hurricane Creek and two of its tributaries, North Fork Hurricane Creek and Little Hurricane Creek. The metals impairments, which include aluminum, arsenic, chromium, iron and copper, have been attributed by the State to acid mine drainage (AMD). The turbidity impairments have been attributed to mining, silviculture, and residential development. The pathogen impairments are likely caused by nonpoint sources in the watershed such as cattle in the stream and failing septic systems.

Table 1: 303(d) Listed Waterbodies and Impairments

Listed Segment ID	Stream Name	Length (mi)	Designated Use	Impairments	Sources
AL 03160112-120 01	Hurricane Creek	31.4	Fish & Wildlife	Aluminum, Pathogens, Turbidity, Iron	Surface mining-abandoned, Land development
AL 03160112-120 02	Little Hurricane Creek	10	Fish & Wildlife	Aluminum, Arsenic, Copper, Chromium, Pathogens, Iron	Surface mining-abandoned
AL 03160112-120 03	North Fork Hurricane Creek	6.4	Fish & Wildlife	Aluminum	Surface mining-abandoned

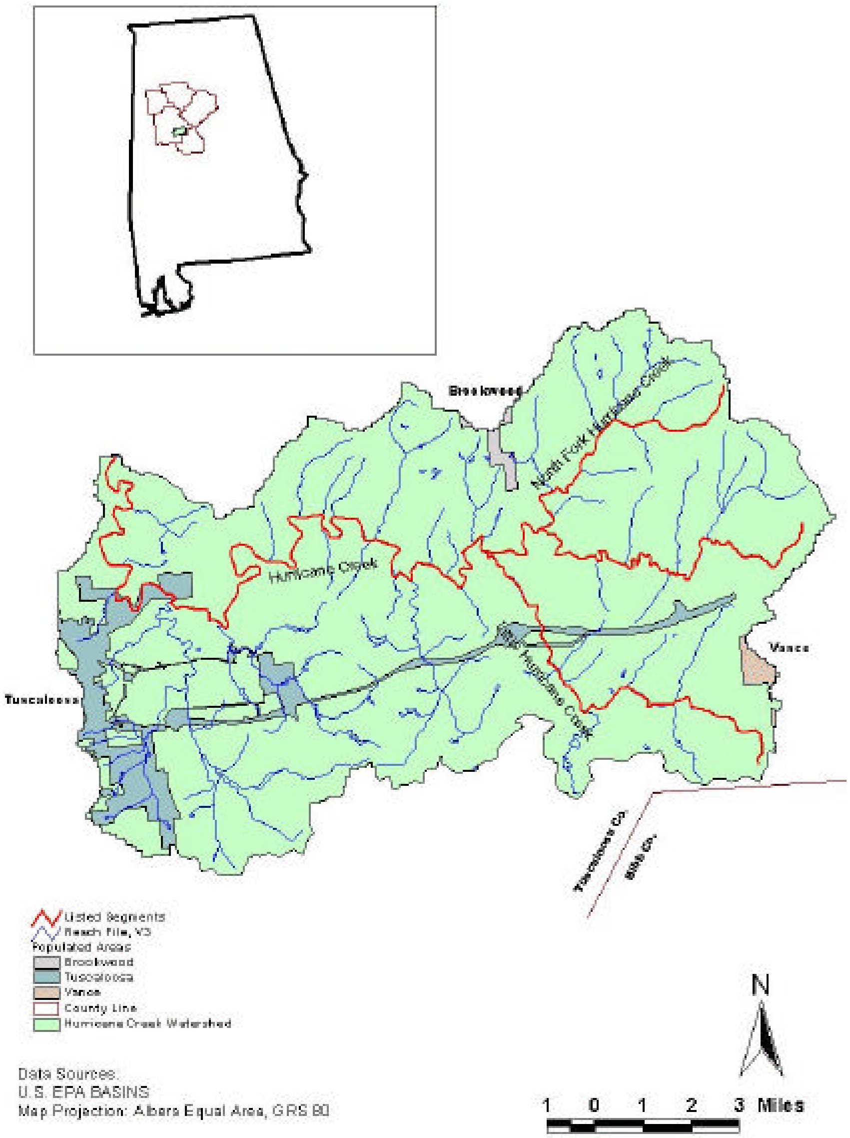

Figure 1: Location Map

3 Applicable Water Quality Standard

Alabama's water quality standards, Chapter 335-6-10 Water Quality Criteria, (ADEM, 2000) have defined water quality criteria for surface waters as a numeric constituent concentration or a narrative statement representing a quality of water that supports one or more designated uses of the waterbody. All listed waterbodies in the Hurricane Creek watershed have been designated as having a fish and wildlife use. Metals and fecal coliform bacteria are given numeric criteria under the fish and wildlife use designation category (See Table 2). The State of Alabama does not currently have numeric water quality standards for aluminum and iron. Therefore, in the case of aluminum and iron, EPA has interpreted Alabama's narrative standard through the use of the federal water quality criteria which are presented below. Hurricane Creek is also listed for pathogens, but water quality criteria for pathogens do not exist, therefore, the narrative standard using fecal coliform bacteria as a pathogen indicator has been interpreted by EPA for use in this TMDL. Fecal coliform will be referred to throughout the rest of this report to represent the pathogen impairment. Turbidity is also given numeric criteria under the fish and wildlife use designation category, but background levels of turbidity need to be determined to apply the criterion.

Table 2: Applicable Water Quality Standards and TMDL Targets

	Fish and Wildlife	
Parameter	**Acute[a]**	**Chronic[b]**
Aluminum, Total (ì g/L)	750	87
Arsenic, Trivalent (ì g/L)	360	190
Copper, Total (ì g/L)	9.2*	6.5*
Chromium, Trivalent (ì g/L)	984*	117*
Iron (mg/l)		1.0
Fecal Coliform[c]	Bacteria of the fecal coliform group shall not exceed a geometric mean of 1,000/100 mL; not to exceed 200/100 mL max geometric mean June-September; nor exceed a maximum of 2,000/100 mL in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours.	
Turbidity[c]	There shall be no turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of waters or interfere with any beneficial uses which they serve. Furthermore, in no case shall turbidity exceed 50 NTU above background. Background will be interpreted as the natural condition of the receiving waters without the influence of man-made or man-induced causes. Turbidity caused by natural runoff will be included in establishing background levels.	

Source:ADEM, 2000; USEPA, 1999

[a] One hour average concentration not be exceeded more than once every three years on the average,

[b] Four-day average concentration not to be exceeded more than once every three years on the average,

[c] Not to exceed

*Hardness of 50 mg/l

4 Source Assessment

This section identifies the potential sources of aluminum, arsenic, chromium, copper, iron, fecal coliform, and turbidity in the Hurricane Creek watershed. A wide range of data sources were used to identify potential sources and to characterize the relationship between point and nonpoint source discharges and in-stream response at monitoring stations.

4.1 Data Inventory

A wide range of data and information were used to characterize the watershed. The categories of data used include physiographic data that describe the physical conditions of the watershed, environmental monitoring data that identify potential pollutant sources and their contribution, and in-stream water quality monitoring data. Table 3 shows the various data types and data sources used in this inventory.

Table 3: Data and Information Inventory

Data Category	Description	Data Source(s)
Watershed Physiographic Data	Land Use (MRLC) (mid 1990s)	USGS
	Abandoned Mining Coverage	Alabama Abandoned Mine Land Reclamation Division
	Stream Reach Coverage Reach File, Version 3	USEPA's BASINS
	Weather Information	National Climatic Data Center
Environmental Monitoring Data	NPDES Data	ADEM
	Permitted Mining Data	Alabama Surface Mining Commission
	Discharge Monitoring Report Data	Alabama Surface Mining Commission
	303(d) Listed Waters	ADEM
	Water Quality Monitoring Data for 11 Sampling Stations	EPA STORET and ADEM

4.2 Stream Flow Data

There are three USGS flow gages in the Hurricane Creek watershed. Flow data from two of these gages were used to support a flow analysis for the watershed.

4.3 Nonpoint Sources

In order to characterize the contributing nonpoint sources in the Hurricane Creek watershed, the nonpoint sources were classified into three major categories: metals sources, fecal coliform sources, and turbidity sources.

4.4 Metals Sources

Nonpoint sources represent contributions from diffuse, non-permitted sources. Based on the identification of a number of abandoned mining sites in the Hurricane Creek watershed, abandoned mine lands (AML) represent a critical nonpoint source. Abandoned mines can contribute significant amounts of acid mine drainage, which causes low pH and high metals concentrations in surface and subsurface water in areas where mining activities are or once were present. Because AMLs are present in the Hurricane Creek watershed in such abundance, nonpoint source contributions were grouped for assessment into two separate categories: AML and other nonpoint sources.

The metals impairments in the Hurricane Creek watershed are mainly caused by acid mine drainage (AMD) in the watershed. Acid mine drainage occurs when surface and subsurface water percolates through coal bearing minerals containing high concentrations of pyrite and marcasite, which are crystalline forms of iron sulfide. It is these chemical reactions of the pyrite which generate acidity in water. Acid mine drainage is in turn related to the geology of the watershed and its surrounding area. Background information on the geology of the watershed and the chemical processes affecting minerals associated with the geologic formations is essential in determining sources of pollutants to the impaired water bodies.

4.4.1 Hurricane Creek Geology

Geologically, the Hurricane Creek watershed is composed primarily of clays, sands and limestones of the Tuscaloosa Group. The rest of the watershed is composed of the Upper Pottsville Formation of the Pennsylvanian age. This level of the Pottsville Formation is composed of sandstones, shales (mudstones) and large discontinuous coal beds. The area of the Hurricane Creek watershed covered by the Pottsville Formation is part of the Warrior Coal Field. The coal beds in this area have been enriched over time by a diverse group of trace elements and metals including arsenic, copper, iron, and pyrite (USGS: MR-2357, 2000). The average concentration of arsenic in Alabama coal (72 parts per million (ppm)) is three times higher than the national average (24 ppm). The Warrior Coal Field has some of the highest arsenic concentrations in Alabama with many observed concentrations above 200 ppm (USGS: MF-2333, 2000).

4.4.2 Acid Mine Drainage (AMD)

AMD occurs when surface and subsurface water percolates through coal bearing minerals containing high concentrations of pyrite and marcasite, which are crystalline forms of iron sulfide (FeS_2). In addition, sulfides of copper and arsenic will undergo similar geochemical reactions resulting in the contribution of toxic metal ions into mine wastewater. Depending on geological factors, the metals found in mining waste may include arsenic, copper, chromium, and aluminum as well as other metals (Environmental Mining Council of British Columbia 2001)

4.4.3 Abandoned Mine Lands (AML)

There have been both surface and deep mining activities in the Hurricane Creek watershed and consequently numerous AML sites which produce AMD flows (ASMC, 2001) (See Figure 2). Data regarding AML sites in the Hurricane Creek watershed were compiled from GIS coverages provided by the Alabama Surface Mining Commission (ASMC) and personal communication with Larry Barwick from the Alabama AML Reclamation Division. Information regarding the abandoned mines in the Hurricane Creek watershed is presented in Table 4.

4.4.4 Permitted Mining Point Sources

Mining related point source discharges, from deep, surface, and other mines, typically contain high concentrations of metals. Consequently, mining related activities are commonly issued discharge permits for these parameters. The Alabama Surface Mining Commission provided a spatial coverage of the mining permit data. The coverage includes both active and inactive coal mining facilities.

Coal mining operations typically have permits limits for total iron, total manganese, total suspended solids, and pH (See Table 5). There are a total of 2 active and 49 closed or expired mining discharge permits in the Hurricane Creek watershed. The mining facilities are located mainly in the northern portion of the watershed, with some facilities located along Hurricane Creek and Kepple Creek (See Figure 3). A complete listing of mining permits in the Hurricane Creek watershed is located in Hurricane Creek Watershed Modeling Report

(See Appendix A).

Table 4: Abandoned Mine Areas

Problem Area Number	Area (acres)	Mining Features	Reclaimed / Unreclaimed	Problem Area Name
AL000012SGA	43	Spoil area	U	KLONDIKE EAST
AL000013CIA/SGA/RMA	20	Spoil area	R	FLEETWOOD
AL000026RMA/SGA	153	Spoil Area	R	KLONDIKE, WEST
AL000029SGA	23	Spoil Area	R	HOWTON, SOUTH
AL000043SGA	240	Spoil Area	U	NORTH ALABAMA JUNCTION E
AL000172SGA	unknown	3 portals	R	CEDAR COVE
AL000172SGA	unknown	14 mine openings	U	CEDAR COVE
AL000476SGA	unknown	46 mine openings	R	TUSCALOOSA, EAST
AL000607SGA	16	Spoil area	R	DUDLEY
AL000619SGA	20	Spoil area	U	CEDAR COVE, WEST
AL000710SGA	184	Spoil area		HANNA MILL CREEK
AL000720RUA/SGA	40	Spoil area	R/U	FLEETWOOD, NORTH
AL000841CIA	10	Spoil area	R	ALCO

Table 5: Typical permitted mining limits

Parameter	Daily Minimum	Daily Average	Daily Maximum
Iron, Total (mg/L)	N/A	3.0	6.0
Manganese, Total (mg/L)	N/A	2.0	4.0
Total Suspended Solids (mg/L)	N/A	35.0	70.0
PH	6	N/A	9
Flow	Instantaneous, determine at time of sample collection		

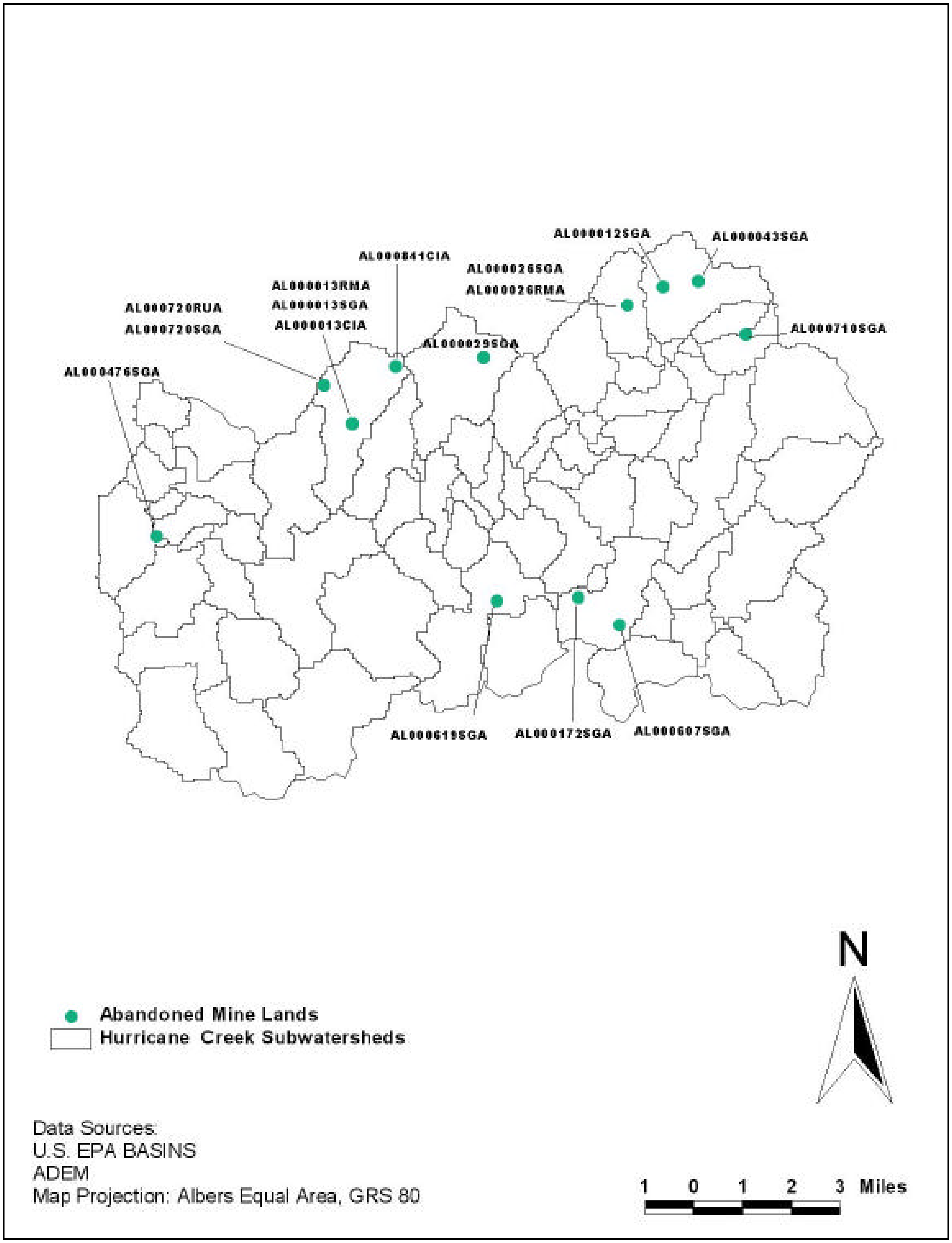

Figure 2: Abandoned Mine Locations

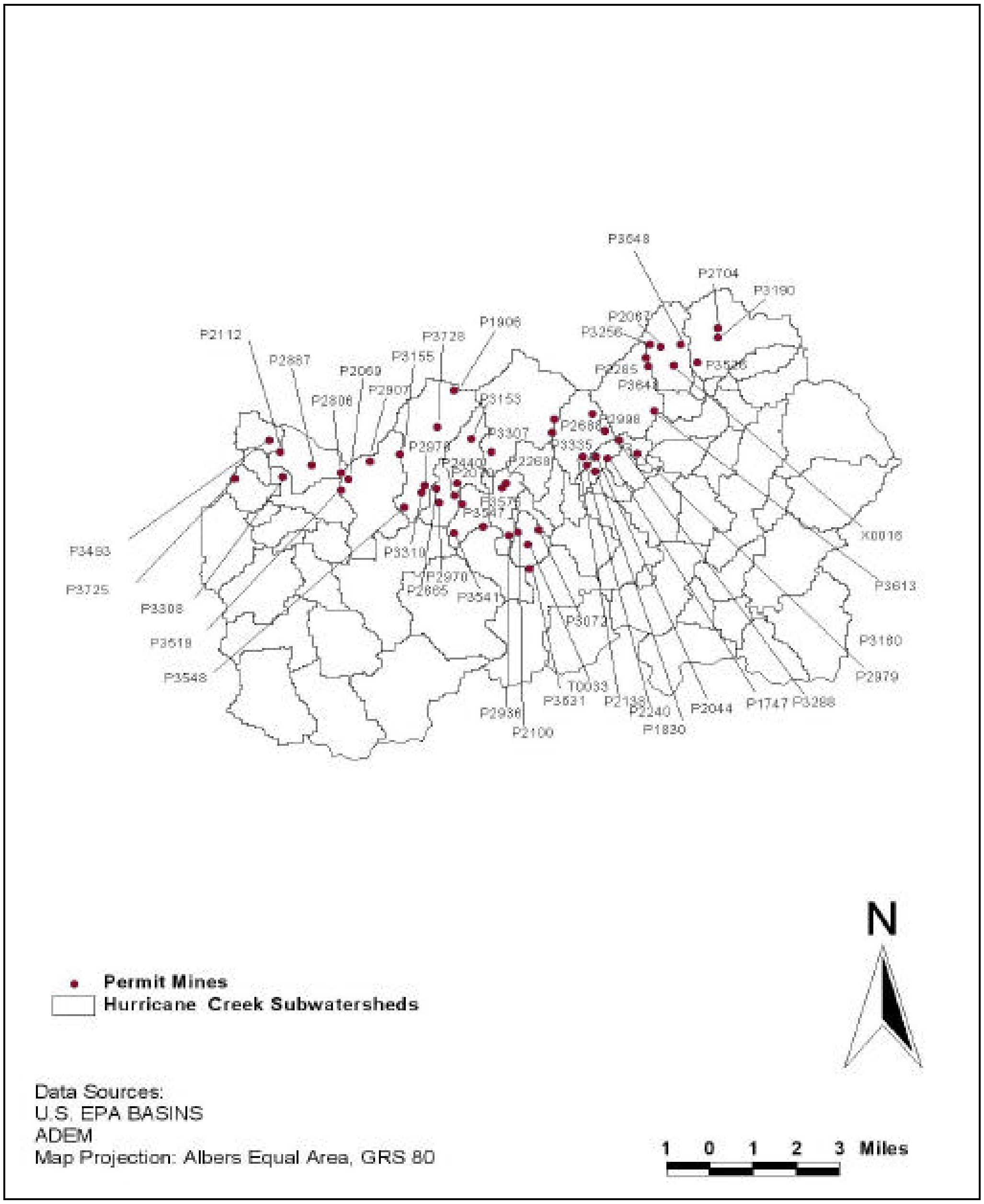

Figure 3: Permitted Mine Locations

4.4.5 Other Nonpoint Sources

The predominant land uses in the Hurricane Creek watershed were identified based on the USGS's Multi-Resolution Land Characterization (MRLC) land use data (representative of the mid-1990's). According to the MRLC data, the major land uses in the watershed are forest land, which constitutes approximately 67 percent of the watershed area. In addition to forest land, other land uses which may contribute nonpoint source metals loads to the receiving streams include barren and urban land. The land use distribution for the Hurricane

Creek watershed is presented in Figure 4. Because of the coal fields in the watershed, concentrations of metals are high in the watershed. It is likely that higher metals loadings are contributed by barren, harvested, strip mined, or agricultural land due to the fact that runoff and erosion potential is greater for these land uses and the metals can be associated with the sediment.

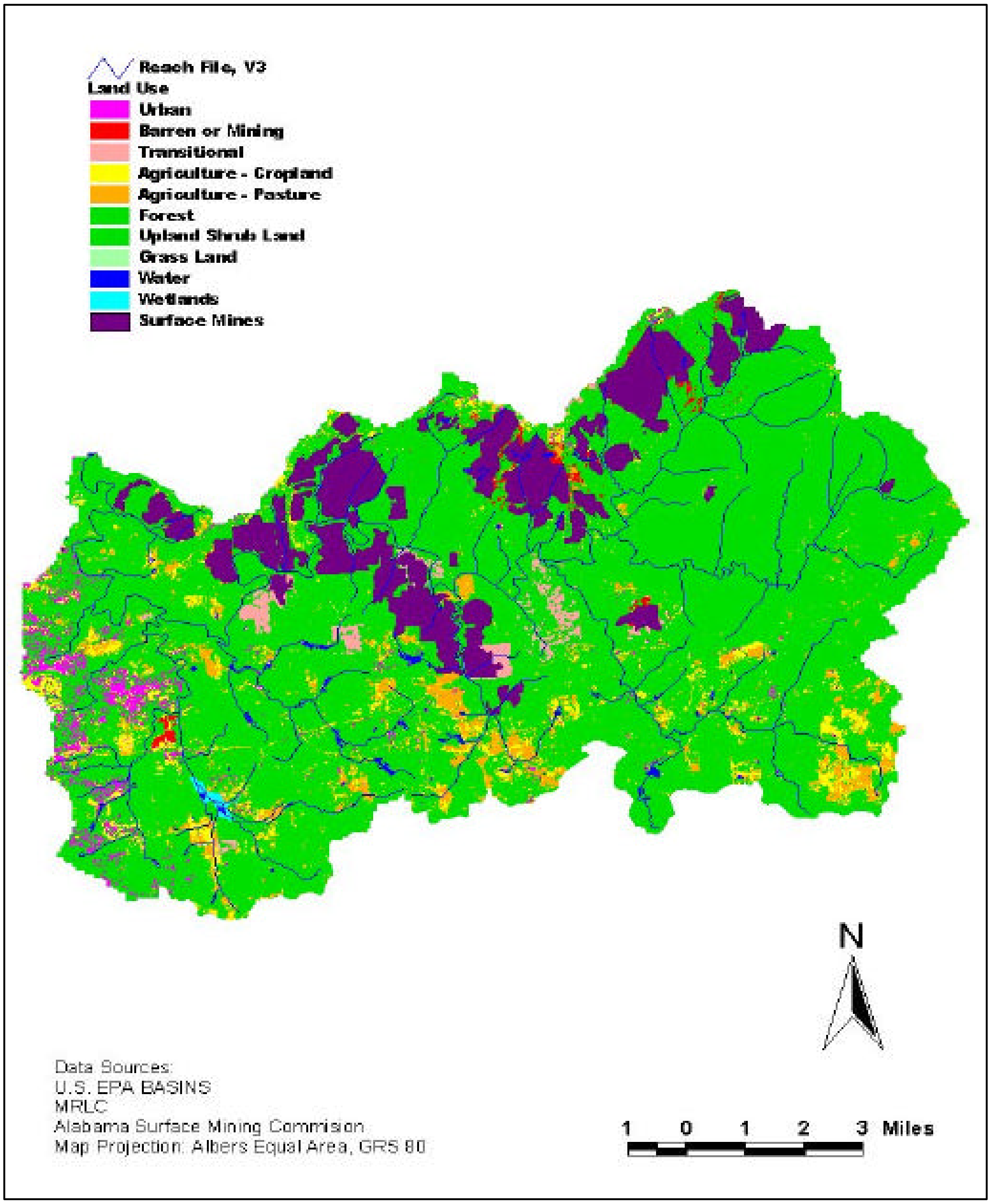

Figure 4. Land use in the Hurricane Creek Watershed

4.5 Fecal Coliform Sources

The Alabama water quality criteria for pathogens are based on fecal coliform bacteria as an indicator organism. Comparison of fecal coliform levels at water quality station H-1 to simulated flow data (observed flow data were not available for this particular time period) at the corresponding time shows that fecal coliform concentrations are present in relatively high concentrations at both high and low flow conditions, indicating that there may be a number of sources contributing to fecal coliform impairment in the watershed. Nonpoint wet weather sources of fecal coliform bacteria are typically separated into urban and rural components. Large areas of paved impervious surfaces typically characterize urban settings. Important sources of fecal coliform loads in urban areas are storm runoff from impervious and pervious areas, failing septic tanks, illicit discharges, and leaking sanitary sewer systems. In rural settings, the amount of impervious area is usually much lower, resulting in greater infiltration of precipitation and less runoff. Sources of fecal coliform in rural areas may include runoff from fields receiving land application of animal wastes, runoff from concentrated animal operations and grazing land, contributions from wildlife, cattle in the stream, and failing septic tanks. No concentrated animal operations where identified as being present in the watershed. Three minor domestic waste point sources are present and contribute a small fecal coliform discharge concentration of 200 counts per 100 ml.

The Hurricane Creek watershed was evaluated to identify and quantify sources of bacteria within the watersheds of the listed segments. The identified potential nonpoint sources of fecal coliform bacteria within the watersheds of the listed segments include:

- Runoff from pastureland with grazing livestock
- Runoff from cropland
- Failing septic systems
- Wildlife contributions
- Cattle in streams
- Runoff from residential and urban areas
- Three minor point source discharges

4.5.1 Grazing Livestock

Grazing cattle and other agricultural animals deposit manure and, therefore, fecal coliform on the land surface, where it is available for washoff and delivery to receiving water bodies. Although specific information regarding agricultural management practices and activities are not readily available, ADEM keeps a database of agricultural and land use information provided by the various Soil and Water Conservation Districts within the

State. The information in the database is based on the Agricultural Census. Data from ADEM's agricultural database provided estimates of livestock in the Hurricane Creek watershed. Total pastureland within the watershed was provided by the MRLC land use coverage. The livestock counts and pasture areas were used to determine livestock densities (e.g., number of cows per acres of pastureland) for the watershed, assuming livestock are evenly distributed over pasture area.

Table 6: Total Livestock Counts for the Hurricane Creek Watershed

Cattle	Hogs	Chickens
580	36	186,480

4.5.2 Failing Septic Systems

Septic systems are common in unincorporated portions of the watershed and may be direct or indirect sources of bacterial pollution via ground and surface waters. A high percentage of the citizens in the Hurricane Creek watershed rely on septic systems for wastewater treatment (Tuscaloosa Environmental Health Department, 2001). ADEM provided the numbers and failure rates in the Hurricane Creek watershed. Onsite septic systems have the potential to deliver fecal coliform bacteria loads to surface waters due to system failure and malfunction. The number of septic systems in the Hurricane Creek watershed was provided by ADEM, but the spatial distribution of septic tanks is not known. For modeling purposes, spatial distribution was assumed to be partially correlated with areas of low-intensity residential land. Fifty percent of the septic systems in the watershed were distributed based on the location of low-intensity residential land use areas and the remaining 50 percent were distributed evenly throughout the watershed (based on density) to account for individual homes and businesses not represented in the low-intensity residential land use coverage.

After estimating the number of septic systems per watershed, the number of failing systems per sub watershed was determined in order to calculate bacteria loading. ADEM (2001) estimates the septic system failure rate in the Hurricane Creek watershed to be approximately 10 percent. It was assumed that failing systems are distributed evenly throughout the watershed area.

4.5.3 Wildlife

Wildlife is another potential source of fecal coliform loading to receiving water bodies. For modeling purposes, the deer population is assumed to represent the wildlife contribution, since population data for other wildlife species in the watershed was not provided. It is also assumed that deer habitat within the watershed includes forest, cropland, pasture, and wetland land uses. Typical estimates for distributions of deer within the region were provided by the Alabama Department of Conservation, Division of Wildlife and Freshwater Fisheries (2000). Two different densities (deer per square mile) were available for the watershed, representing different management areas. The provided densities were applied to deer habitat areas within the watershed to estimate population counts by subwatershed. An average density (15 deer/mi^2) was applied to the forest, cropland, pasture, and wetland areas.

4.5.4 Cattle in the Stream

ADEM's Agricultural Database provided information stating that livestock commonly have access to streams. When cattle are not denied access to stream reaches, they represent a major potential source of direct fecal coliform loading to the stream. To account for the potential influence of cattle loads deposited directly in stream reaches within the watersheds, fecal coliform loads from cattle in streams were calculated and characterized as a direct source of loading to the stream segments. To determine the number of cows in the stream at any time, certain assumptions were made based on discussions with agricultural agencies in the southeast. For this TMDL, it was assumed that 10 percent of the cows in the watershed have access to streams; that 7 percent of those cows are in or around the stream at any given time; and that 5 percent of those cows in the stream are actually depositing manure in the stream reach at any given time.

4.6 Turbidity Sources

Thirty five percent of the 241 turbidity observations at water quality station H-1from 1/13/76 to 12/9/96 were exceeding the water quality criterion based on a background turbidity concentration of 13 NTU that was used for listing on the 1998 303(d) list. Turbidity is measured in NTUs, not a concentration, so another parameter that is measured as a concentration must be used to represent turbidity loadings in the watershed. Turbidity can be an indicator of high levels of suspended solids or of high total dissolved solids caused by high metal levels in the watershed. Controls for the total dissolved solids will be accomplished by controlling the high metals concentrations and a TMDL for TSS will be completed to address the excess sediment.

Total suspended solids (TSS) is used as the turbidity indicator in this project based on the assumption that sources of turbidity in the watershed are sediment loadings from the large amounts of disturbed mining land as well as urban/residential land, unpaved roads, and silviculture. Turbidity tends to be highest in the spring and appears to be correlated with high runoff and erosion from disturbed land and iron precipitates formed by AMD. Mining, silviculture, and urban/residential land have been identified as the most likely contributors of sediment and turbidity to the Hurricane Creek watershed based on water quality data analysis and literature on the Hurricane Creek watershed. The urbanization and paving of large areas of the watershed can result in dramatic increases in stormwater runoff, which leads to periodic high flows that erode stream banks and contribute increased amounts of sediment and turbidity to the creek. These nonpoint sources are extremely difficult to pinpoint, measure, and control, but they are a possible cause of degradation of the habitat and the biological indicators measured in the Hurricane Creek basin. (Appendix B)

4.6.1 Agricultural Land

Agricultural runoff from cropland and pasture can often contribute increased pollutant loads to a water body when poor farm management practices allow soils or animal waste to be washed into the stream, increasing in-stream sediment levels. Based on the MRLC land use coverage, the cropland percentage in the impaired watersheds ranges from 0 to 14.5 percent. When hay/pasture and cropland are combined, the percentage of agricultural land ranges from 0 to 32.7 percent.

4.6.2 Urban/Residential Areas

Urban and residential areas are represented in the MRLC land use coverage by the “urban” land use (See Figure 4). Sediment from nonpoint sources may be carried into streams through surface runoff and through erosion from unpaved areas and construction sites. Paved and unpaved roads are potential sources of sediment in populated areas and in some rural areas where logging occurs. Unpaved roads have been indicated by ADEM to be a potential source of TSS to the watershed. The area of unpaved roads was determined by assuming that the unpaved roads are approximately 1/3 of the area of the paved roads. The width assumed for unpaved roads in the watershed was 10 feet. (Appendix A)

4.6.3 Permitted Non-mining Point Sources

Data regarding non-mining point sources were retrieved from ADEM. The non-mining point sources in the

Hurricane Creek watershed typically do not discharge significant amounts of metals and hence do not have permit limits for these pollutants. There are three permitted municipal facilities in the Hurricane Creek watershed permitted to discharge total suspended solids (TSS) and have fecal coliform levels in their discharge. These three sources are included as potential sources of turbidity and fecal coliform to the watershed. Table 7 presents the facility permit information. Fecal coliform levels were assumed to be 200 counts per 100 ml.

Table 7 : Permitted non-mining point sources

NPDES Number	Facility Name	Status	Receiving Water body	TSS Permit Limit (mg/L)	Design Flow (cfs)
AL0050652	Brookwood High School	Active	Tributary to Hurricane Creek	90	0.026
AL0050695	Holt Elementary School	Active	Unnamed Tributary to Hurricane Creek	90	0.03
AL0057517	Brookwood Shell Truck Stop	Active	Unnamed Tributary to Hurricane Creek	90	0.01

Disturbed areas covered by the Alabama General Stormwater permit also have the potential for TSS discharges. Since these sites are transient in nature and discharge in response to rainfall, they are handled as disturbed areas in the non point source analysis.

5 EPA Region 4 and ADEM Biological and Habitat Data and Information

A summary of the available biological and habitat data for the Hurricane Creek watershed is provided below. A detailed assessment of this data is contained in Appendix B.

Macroinvertebrate communities at five sites within the Hurricane Creek watershed were assessed in 1996 by ADEM during an intensive survey of water quality conditions (1996b). An assessment of aquatic macroinvertebrate fauna was also conducted in the North Fork of Hurricane Creek during the 1997 Nonpoint Source Screening Assessment of the Black Warrior River Basin (ADEM 1999). The Alabama Geological Survey assessed fish communities at six sites within the watershed in 1998. These assessments generally indicated that the North Fork Hurricane Creek was severely impaired based on the community structure of the macroinvertebrate assemblages. ADEM identified Hurricane Creek as a priority sub watershed for further ecological evaluation as a result of these findings.

In April 2000, EPA sampled thirteen sampling stations to conduct rapid bioassessment studies in Hurricane Creek, Little Hurricane Creek, North Fork Hurricane Creek, and major tributaries (Kepple and Cottondale Creeks). There was not an established ecological reference site in the Shale Hills ecoregion. However, following a suggestion by ADEM, Wolf Creek was sampled as a possible reference site for this ecoregion.

As a result of these studies, it was determined that six stations identified in Table 8 do not fully support the water quality classification of Fish & Wildlife compared to the reference site based on the macroinvertebrate communities.

Table 8. Comparison of ADEM 1996 and 1997 macroinvertebrate data to U.S. EPA macroinvertebrate data collected in 2000.

2000 U.S. EPA Macroinvertebrate Data				
Station	**# EPT**	**Habitat**	**Conductivity**	**Rating**
NFHT-1	4	good	700 µmhos/cm	impaired
HCRT-2	12	good	424 µmhos/cm	good
HC-2 (same as HCRT-3)	12	good	284 µmhos/cm	good
H-1	8	good/fair	221 µmhos/cm	impaired

1996 and 1997 ADEM Macroinvertebrate Data				
Station	**# EPT**	**Habitat**	**Conductivity**	**Rating**
NFHT-1 1997	3	good/fair	1528 µmhos/cm	severely impaired
HCRT-2 1996	8	good	1697 µmhos/cm	slightly impaired
HCRT-3 1996	8	good	624 µmhos/cm	slightly impaired
H-1 1996	7	good	579 µmhos/cm	moderately impaired

6 Model Development

Establishing the relationship between the in-stream water quality targets and source loadings is a critical component of TMDL development. It allows for evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. The objective of model development is to present the approach taken to develop the linkage between sources and in-stream responses for TMDL development in the Hurricane Creek watershed. Appendix A (The Hurricane Creek Watershed Modeling Report) contains the detailed information on the model development for the Hurricane Creek Watershed.

6.1 Model Framework

Numeric criteria, such as those applicable here, require evaluation of magnitude, frequency, and duration. Thresholds of a numeric measure are often evaluated for frequency of exceedence (e.g., not to exceed more than once every 3 years on average). Acute standards typically require evaluation over short time periods and violations may occur under variable flow conditions. Chronic criteria require the evaluation of the response over a four-day averaging period. The fecal coliform criteria are presented as either a geometric mean using a minimum of 5 consecutive samples over a 30-day period or an instantaneous maximum standard. The approach or modeling technique must permit representation of in-stream concentrations under a variety of flow conditions in order to evaluate critical periods for comparison to chronic and acute criteria.

The appropriate approach must also consider the dominant processes regarding pollutant loadings and in-stream fate. For the Hurricane Creek watershed, primary sources contributing to metals, pathogens, and turbidity impairments include an array of nonpoint or diffuse sources as well as discrete point sources/permitted discharges. Loading processes for nonpoint sources or land-based activities are typically rainfall-driven and thus relate to surface runoff and subsurface discharge to a stream. Permitted discharges may or may not be dependent on rainfall; however, they are controlled by permit limits.

Key in-stream factors that must be considered include routing of flow, dilution, transport, and fate (decay or transformation) of metals, pathogens, and turbidity. In the stream systems of the Hurricane Creek watershed, the primary physical driving process is the transport of metals by diffusion and advection in the flow. Significant chemical processes are the speciation and precipitation of metals followed by sediment adsorption/desorption and redox reactions related to the precipitation reactions. Significant in-stream processes affecting the transport of fecal coliform and sediment include fecal coliform die-off, and deposition and resuspension of sediments.

Based on the considerations described above, analysis of the monitoring data, review of the literature, and past metals, pathogens, and turbidity modeling experience, the Loading Simulation Program C++ (LSPC) was used to represent the source-response linkage in the Hurricane Creek watershed. LSPC is a comprehensive data management and modeling system that is capable of representing loading from nonpoint and point sources found in the Hurricane Creek watershed and simulating in-stream processes. LSPC is based on the Mining Data Analysis System (MDAS), with modifications for non-mining applications. MDAS was developed by EPA Region 3 through mining TMDL applications in Region 3. MDAS has been used in mining TMDL development for the Tygart Valley River, Monongahela River, and Stony River in West Virginia (USEPA, 2000a).

6.2 Loading Simulation Program C++ (LSPC) Overview

LSPC is a system designed to support TMDL development for areas impacted by nonpoint and point sources. LSPC is also capable of supporting TMDL development for pollutants not related to AMD, such as fecal coliform and sediment.

The most critical component of LSPC to TMDL development is the dynamic watershed model, because it provides the linkage between source contributions and in-stream response. The comprehensive watershed model is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and in-stream water quality. It is capable of simulating flow, sediment, metals, nutrients, pesticides, and other conventional pollutants, as well as temperature and pH for pervious and impervious lands and waterbodies.

LSPC was configured for the Hurricane Creek watershed to simulate the watershed as a series of hydrologically connected sub watersheds. Configuration of the model involved subdivision of the Hurricane Creek watershed into modeling units and continuous simulation of flow and water quality for these units using meteorological, landuse, point source loading, and stream data. Specific pollutants that were simulated include aluminum, arsenic, copper, chromium, iron, fecal coliform, and sediment. This section describes the configuration process and key components of the model in greater detail.

To represent watershed loadings and resulting concentrations of metals, fecal coliform, and sediment in Hurricane Creek, North Fork Hurricane Creek, and Little Hurricane Creek, the watershed was divided into 72 sub watersheds. These subwatersheds are presented in Figure 5, and represent hydrologic boundaries. The division was based on elevation data (7.5 minute Digital Elevation Model [DEM] from USGS), stream connectivity (from EPA's Reach File, Version 3 [RF3] stream coverage), and locations of monitoring stations.

LSPC was calibrated for hydrology using 1960s flow data and again using flow data from 1980 (see Section 4.4.1). The Birmingham Airport weather data was used during the 1960s time period because the quality of the rainfall data at Birmingham Airport was higher than Tuscaloosa Oliver Dam at this time period. The Tuscaloosa Oliver Dam station was used for the 1980 calibration due to its closer proximity to the watershed. These weather data were applied to all subwatersheds in the Hurricane Creek watershed.

6.3 Nonpoint Source Representation

6.3.1 Abandoned Mine Lands (AML)

In order to represent AMLs as nonpoint sources, the AML sites were represented as a unique land use category called abandoned mines. The abandoned mines represent either discharge from abandoned deep mines or seeping and leaching from other abandoned mine sites. The discharge from the abandoned mines are simulated both by surface runoff in response to rainfall and by groundwater flow, both of which are included in the water quality model. Abandoned mine locations and respective areas were obtained from the Alabama Abandoned Mine Land Reclamation Division. The AML locations were compared to the location of disturbed mine area provided by ADEM. When AML sites were located within the disturbed mine area, the AML acres were subtracted from the disturbed mine area. When AML sites were not located near any disturbed mines areas, the acres were subtracted from the forest land use.

6.3.2 Fecal Coliform Sources

The nonpoint fecal coliform sources within the Hurricane Creek watershed are represented differently in the model depending on their type and behavior.

Typically, nonpoint sources are characterized by buildup and washoff processes. These sources contribute bacteria to the land surface, where they accumulate and are available for runoff during storm events. These nonpoint sources can be represented in the model as land-based runoff from the land use categories to account for their contribution to coliform loading within the watersheds. Fecal coliform accumulation rates (number per acre per day) can be calculated for each land use based on all sources contributing coliform to the surface of the land use. For this study, where specific sources were identified as contributing to a land use, accumulation rates were calculated. For example, grazing livestock and wildlife are specific sources contributing to land uses within the watershed. Accumulation rates can be derived using the distribution of animals by land use and using typical fecal coliform production rates for different animals. Literature values for typical fecal coliform accumulation rates were used for the urban/residential land uses. The literature value used for residential land uses is 1.43 E+07 counts/ac/day, the average of the default values for low- and high-density residential areas (Horner, 1992). The literature value used for urban land uses is the median default value of 6.19 E+06 counts/ac/day for commercial land (Horner, 1992).

Failing septic systems represent a nonpoint source that can contribute fecal coliform to receiving waterbodies through surface or subsurface malfunctions. To provide for a margin of safety accounting for the uncertainty of the number, location, and behavior (e.g., surface vs. subsurface breakouts; proximity to stream) of the failing systems, failing septic systems are represented in the model as direct sources of fecal coliform to the stream reaches. Fecal coliform contributions from failing septic system discharges are included in the model with a representative flow and concentration.

The septic system contribution in the model inherently contains a margin of safety based on the assumption that all the fecal coliform bacteria discharged from failing septic systems reaches the stream. In reality, it is likely that only a portion of the bacteria will reach the stream after being filtered through the soil or after die-off during transport.

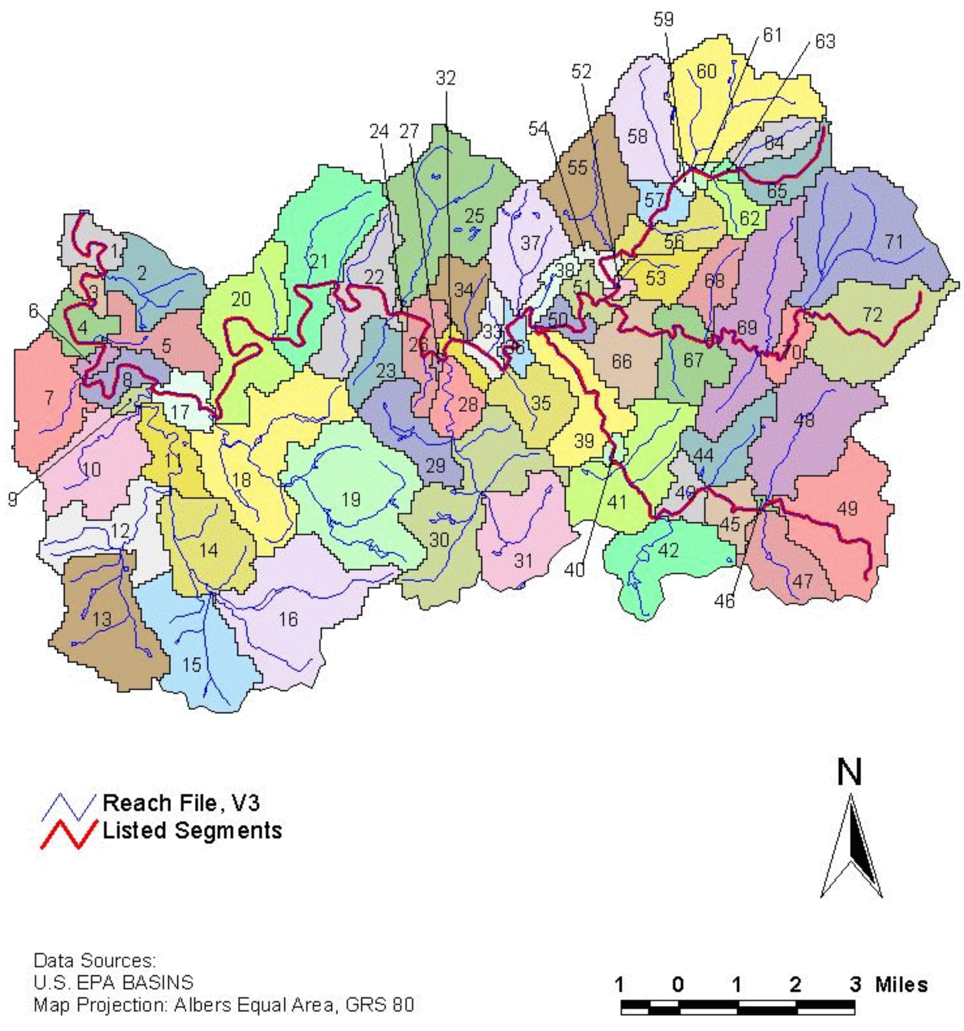

Figure 5: Subwatershed Delineation

Cattle depositing manure directly into stream reaches also represent a direct nonpoint source of fecal coliform. The number of cattle producing and depositing fecal coliform in watershed streams at any give time was estimated, as discussed in Section 3. The cattle were then simulated in the model as direct sources of fecal coliform loads, with a representative flow rate (cubic feet per second) and load (counts per hour).

6.3.3 *Total Suspended Solids (TSS) Sources*

As with fecal coliform, TSS nonpoint sources are typically characterized by buildup and washoff processes. Based on analysis of the water quality data in Hurricane Creek watershed, possible nonpoint sources of TSS include abandoned mines, strip mining, barren land, harvested forest, forest, roads, and agriculture. The contributions of TSS to the watershed from these sources are discussed in Section 3. Soils detachment by rainfall on the contributing land uses is represented in the sediment module of LSPC. The detached sediment removed by surface flow and is washed off into the stream reach where it eventually settles or is resuspended in the water column. Actual TSS loading rates from the various land uses will be determined during water quality calibration.

6.4 Point Sources Representation

6.4.1 *Permitted Non-mining Point Sources*

There are only three non-mining point source permits in the Hurricane Creek watershed. The point sources are permitted to discharge TSS. These point sources are included in the model with a constant flow. The representative constant flow is the design flow provided in the NPDES permit of each facility. These are minor facilities and most likely do not represent a significant source of turbidity to the watershed.

6.4.2 Permitted Mining Point Sources

To account for the permitted mining point sources in the watershed, the disturbed mine areas provided by Alabama Surface Mining Commission were overlaid on the MRLC land use coverage and land use areas covered by disturbed mine were subtracted from the watershed and replaced by the disturbed mine area.

The disturbed mine area was added to the remaining strip mining land use. The size of each mine was assumed to be equivalent to the surface disturbed area. Specific disturbed acreage was not available for the underground mines, therefore an area of 1 acre per mine opening or portal was assumed, based on information in the Tygart Watershed TMDL, for their initial inclusion in LSPC (USEPA, 2000a).

6.5 Stream Representation

Modeling sub watersheds and calibrating hydrologic and water quality model components required the routing of flow and pollutants through streams. Each sub watershed was represented with a single stream. Stream segments were identified using EPA's RF3 stream coverage.

In order to route flow and pollutants, development of rating curves was required. Rating curves were developed for each stream using Manning's equation and representative stream data. Required stream data includes slope, Manning's roughness coefficient, and stream dimensions including mean and channel widths and depths. Manning's roughness coefficient was assumed to be 0.05 for all streams (representative of natural streams). Slopes were calculated based on digital elevation model (DEM) data and stream lengths measured from the RF3 stream coverage. Stream dimensions were estimated using regression curves that relate upstream drainage area to stream dimensions (Rosgen, 1996).

6.5.1 Pollutant Representation

In addition to flow, seven pollutants were modeled with LSPC:

- Total aluminum
- Total arsenic
- Total chromium
- Total copper
- Iron
- Fecal coliform bacteria
- TSS

6.6 Model Calibration

After the model was configured, calibration was performed at multiple locations throughout the Hurricane

Creek watershed. Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. Model calibration focused on two main areas: hydrology and water quality. Upon completion of the calibration at selected locations, a calibrated dataset containing parameter values for modeled sources and pollutants was developed. This dataset was applied to areas where calibration data were not available.

6.6.1 Hydrology Calibration

Hydrology was the first model component calibrated. The hydrology calibration involved a comparison of model results to in-stream flow observations at selected locations and the subsequent adjustment of hydrologic parameters. Key considerations included the overall water balance, the high-flow/low-flow distribution, storm flows, and seasonal variation. To best represent hydrologic variability throughout the watershed, two locations with daily flow monitoring data were selected for calibration (See Figure 6). The stations were USGS #02463500 on Hurricane Creek and USGS #02463510 on Hurricane Creek. Recent time series flow data were not available for hydrology calibration in the Hurricane Creek watershed, therefore, the model was calibrated for two earlier time periods. The model was calibrated using flow data at USGS gage 2463510 for the 10-year period of 1960-1969. This time period represents pre-mining conditions in the watershed, so the model was calibrated based on the original land uses (disturbed mining area was not included). Mining was more prevalent after the 1960s, so after the 10-year 1960s calibration, the mining land uses were added to the model and it was re-calibrated using USGS flow gage 2463500, a station close to 2463510 that has flow data for the time period of 10/1/80 to 9/30/81. This is the most recent time series flow data available in the watershed. The model was calibrated for the years 1960-1969 and 1980 because these were the most recent flow data available and represent a range of hydrologic conditions. Temporal comparisons and comparisons of high flows and low flows were developed to support calibration. The calibration involved adjustment of infiltration, subsurface storage, evapotranspiration, surface runoff, and interception storage parameters.

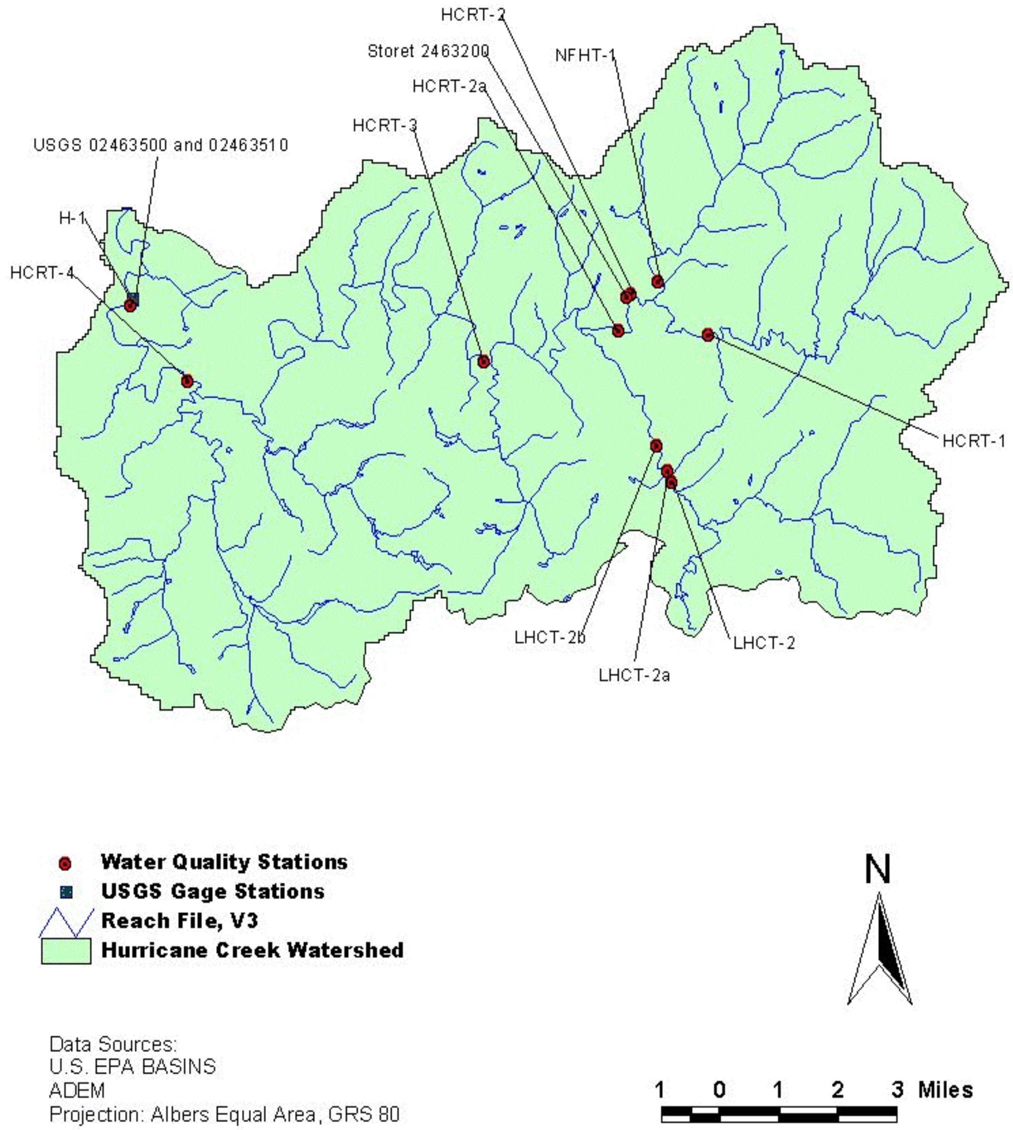

Figure 6. Calibration locations used in modeling

6.6.2 Water Quality Calibration

Following hydrology calibration, the water quality constituents are calibrated. Modeled versus observed in-stream concentrations will be directly compared during model calibration. The water quality calibration consists of executing the watershed model, comparing water quality time series output to available water quality observation data, and adjusting water quality parameters within a reasonable range.

7 Total Maximum Daily Load (TMDL) Development Process

The TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard, in this case, Alabama's numeric water quality standards for aquatic life.

7.1 Critical Condition Determination

The 1980 through 1998 flow period was used to evaluate the instream metals, fecal coliform and sediment conditions. The average annual flow period of 1992 to 1998 was selected as a period that represents the critical conditions for determining the daily maximum allowable pollutant load and concentrations. This period represented a low, average and high flow period and, based on the 1980 to 1998 flow period, had the highest instream concentrations. The daily maximum load or concentration can be viewed as being the "acute" concentration the stream can handle.

7.2 Seasonal Variation

Metals concentrations, fecal coliform and sediment are mostly a wet weather problem and their concentrations and loadings are expected to fluctuate based on the amount and distribution of rainfall. To adequately address the wet weather related problem, a long term simulation covering a variety of hydrologic and rainfall conditions must be evaluated. The flow years of 1980 through

1998 were simulated and a critical period of 1992 through 1998 was selected to be the basis of the TMDL.

7.3 Margin of Safety

A Margin of Safety (MOS) is a required component of a TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody. An implicit MOS was included in TMDL development through 1) application of a dynamic model for simulating daily loading over a wide range of hydrologic and environmental conditions and the selection of a critical flow period that represents low, medium and high flow conditions; 2) through the use of conservative assumptions in model calibration and scenario development, such as assuming a low hardness value, conservative instream decay rates and land loading rates; and 3) the modeling of total metal concentrations instead of the dissolved or other forms.

7.4 TMDL Development Allocation Analysis

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$\text{TMDL} = \text{WLAs} + \text{LAs} + \text{MOS (implicit)}$$

In order to develop TMDLs for each of the waterbodies, the following approach was taken:

- Define TMDL endpoints;
- Simulate baseline conditions;
- Assess source loading alternatives; and
- Determine the TMDL and source allocations

7.4.1 TMDL Endpoints

TMDL endpoints represent the in-stream water quality targets used in quantifying TMDLs and their individual components. Different TMDL endpoints are necessary for each pollutant. The daily "acute" value was selected as the TMDL target.

Aluminum

The TMDL endpoint for aluminum was selected as a 1 day maximum of 750 ug/L based on the 750 ug/L acute criterion for aquatic life.

Arsenic

The TMDL endpoint for arsenic was selected as a 1 day maximum of 360 ug/L based on the acute criterion for aquatic life.

Total Chromium

The TMDL endpoint for chromium was selected as a 1 day maximum of 984 ug/L based on the acute criterion for aquatic life, assuming a 50 mg/l hardness.

Copper

The TMDL endpoint for copper was selected as an 1 day maximum of 9.2 ug/L based on the acute criterion for aquatic life, assuming a 50 mg/l hardness.

Iron

The TMDL endpoint for iron was selected as 1 mg/L based on the EPA criterion.

Fecal Coliform

The TMDL endpoint for fecal coliform was selected as 200 counts per 100 ml for 30 day geometric mean based on the recreational use criterion.

Turbidity

The TMDL endpoint for turbidity was selected as 50 NTUs over background as determined by unimpacted watershed modeling results. The modeling used TSS (total suspended solids) as an indicator for turbidity. A relationship of:

$$\text{Turbidity (NTU)} = 1.8 * \text{TSS (mg/l)} + 11$$

was established based on 1996 site specific data collected by Alabama (See Appendix D). For an increase of 50 turbidity NTUs, an equivalent increase of TSS is 21.5 mg/l. This will be applied on a daily basis.

7.4.2 Baseline Conditions

The calibrated model provided the basis for performing the allocation analysis. The first step in this analysis involved simulation of baseline conditions. Baseline conditions represent existing nonpoint source loading conditions and permitted point source discharge conditions. The baseline conditions allow for an evaluation of in-stream water quality under the “worst currently allowable” scenario.

The model was run for baseline critical conditions for the period January 1, 1980 through December 31, 1998. Predicted in-stream concentrations of listed pollutants for the impaired waterbodies were compared directly to the TMDL endpoints. This comparison allowed evaluation of the expected magnitude and frequency of exceedence under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods.

7.4.3 Source Loading Alternatives

Simulation of baseline conditions provided the basis for evaluating each stream’s response to variations in source contributions under virtually all conditions. This sensitivity analysis gave insight into the dominant sources and how potential decreases in loads would affect in-stream metals concentrations. For example, loading contributions from abandoned mines, permitted facilities, and other nonpoint sources were individually adjusted and in-stream concentrations were observed.

Multiple scenarios were run for the impaired waterbodies. Successful scenarios were those that achieved the TMDL endpoints under all conditions for the listed pollutants (through comparison of model results for the 1992 to 1998 modeling period). In general, loads contributed by abandoned mines and revoked mines were reduced first, because they generally had the greatest impact on in-stream concentrations. If additional load reductions were required to meet the TMDL endpoints, then reductions were made in point source (permitted) contributions.

7.4.4 TMDLs and Source Allocations

A top-down methodology was followed to develop the TMDLs and allocate loads to sources. Impaired headwaters were first analyzed because their impact frequently had a profound effect on down-stream water quality. Loading contributions were reduced from applicable sources for these waterbodies and TMDLs were developed. Model results from the selected successful scenarios were then routed through down-stream waterbodies. Therefore, when TMDLs were developed for down-stream impaired waterbodies, up-stream contributions were representing conditions meeting water quality criteria. Using this method, contributions from all sources were weighted equitably. In some situations, reductions in sources impacting unimpaired headwaters were required in order to meet downstream water quality criteria. In other situations, reductions in sources impacting impaired headwaters ultimately led to improvements far down-stream. This effectually decreased required loading reductions from many potential down-stream sources.

7.5 Wasteload Allocations (WLAs)

Permitted facilities that exist in the watershed include three minor dischargers of TSS and fecal coliform and the two active mine dischargers with a permitted iron limit of 3 mg/l. These facilities are all located in the North Fork Hurricane Creek Watershed. This watershed is included on the State's 303(d) list as impaired for aluminum. Since these facilities are permitted for fecal coliform, TSS or iron, and not for aluminum, they are not considered to be causing nor contributing to the North Fork Hurricane Creek watershed's aluminum impairment. Because there are no facilities permitted for the constituents of concern in the impaired segments in the Hurricane Creek watershed, the WLAs for the watershed are presumed to be zero.

Loading revoked permitted facilities was assumed to be a nonpoint source contribution based on the absence of a permittee.

7.6 Load Allocations (LAs)

Load allocations (LAs) were made for the dominant source categories, as follows:

- Abandoned mine lands (including abandoned mines (deep), high walls, and disturbed areas), strip mines (areas represented in the land use coverage, but not accounted for by permits or AMLs)
- Other nonpoint sources (urban, agricultural, and forested land contributions)
- Revoked permits - (loading from revoked permitted facilities)

8 TMDLs

8.1 North Fork Hurricane Creek

North Fork Hurricane Creek is listed as impaired by aluminum. The biological data confirms that the North Fork is severely impaired for biology, but the habitat is good. This confirms that an instream pollutant other than sediment is causing the problem. Based on the chemical data, aluminum is the likely the cause of impairment.

The following table provides the TMDL and percent reduction in aluminum loads needed to meet the 750 ug/l aluminum target. The loadings are given for the whole North Fork Hurricane Creek watershed. Appendix C lists the breakdown by subwatersheds in the North Fork Hurricane Creek Watershed.

8.1.1 Aluminum TMDL

Table 9: North Fork Hurricane Creek Aluminum Baseline and TMDL

North Fork Hurricane Creek Watershed	Aluminum (pounds/year)

Baseline	76,140
TMDL	19,000
Percent Reduction	75%

The major sources of aluminum load are the strip mines and abandoned mine drainage in the watershed. To meet the TMDL value, a reduction of over 90% of the aluminum load coming from these sources must be achieved. Also since aluminum is present in the sediment coming from the watershed, another way to reduce the aluminum load is to reduce or at least maintain the current sediment loading to the streams. Since there are no permitted discharges of aluminum in the watershed, no WLA is established.

8.2 Little Hurricane Creek

Little Hurricane Creek is listed as impaired by aluminum, arsenic, copper, chromium, iron and pathogens. After further review of the data and modeling results, it was evident the impairment listings for chromium and arsenic were incorrect. The Creek is meeting the State's water quality standards for these two pollutants and no reductions are needed. Also, after reviewing the biological and habitat data, it was determined that the stream is not biologically impaired. Based on this analysis, TMDLs, therefore, not needed for chromium and arsenic for Little Hurricane Creek.

The following table provides the baseline loads, the TMDL and percent reduction in aluminum, copper, iron and pathogens loads needed to meet the TMDL targets. Since no further reduction in loads are needed for chromium and arsenic, the baseline loadings are provided for chromium and arsenic only. The loadings are given for the Little Hurricane Creek watershed. Appendix C lists the breakdown by subwatersheds in the Little Hurricane Creek Watershed.

Table 10: Little Hurricane Creek Baseline and TMDL Loads

Little Hurricane Creek Watershed	Aluminum (pounds/yr.)	Arsenic (pounds/yr.)	Copper (pounds/yr.)	Total Chromium (pounds/yr.)	Iron (pounds/ yr.)	Fecal Coliform Load (counts/100 ml *flow)
Baseline	24,990	141	154	153	2120	8,960,000

TMDL	10,000	NA	62	NA	1480	1,800,000
Percent Reduction	60	--	60	--	30	80

The major source of aluminum, copper and iron is related to sediment runoff from disturbed areas and one major abandoned mine area located in the lower Little Hurricane Watershed. To meet the required reductions, runoff from the AML and sediment erosion will need to be controlled. One mechanism is to include limits and stringent BMP requirements in the general stormwater permits for the area.

Fecal coliform reductions are needed mostly from agriculture lands and leaky septic tanks.

8.3 Hurricane Creek

Hurricane Creek is listed as impaired by aluminum, iron, pathogens and turbidity. The biological data confirms that Hurricane Creek is impaired for biology and in some areas the habitat is degraded. Based on the chemical data, aluminum and iron are the likely pollutants causing instream toxicity problems. Turbidity due to excess sediment is causing the habitat problems. Habitat evaluations indicated degradation in the lower Hurricane Creek Watershed (See Appendix B). Again some of the turbidity problem may be due to TDS related to the high metals concentration. As the metals concentrations are reduced, the turbidity related to the metals, should also be reduced.

The following table provides the TMDL for aluminum, iron, pathogens and turbidity loads needed to meet the TMDL targets. The loadings are given for the Hurricane Creek watershed. Appendix C lists the breakdown by subwatersheds in the Hurricane Creek Watershed.

Table 11: Hurricane Creek Baseline and TMDL Loads

Little Hurricane Creek Watershed	Aluminum (pounds/yr.)	TSS (pounds/yr.)	Iron (pounds/yr.)	Fecal Coliform Load (counts/100 ml * flow)
Baseline	319,362	9,550	240,000	1,030,000,000

TMDL	9,000	6,880	204,000	300,000,000
Percent Reduction	60	30	15	70

The major source of aluminum and iron (and partial cause of turbidity) are the strip mines and abandoned mine drainage in the watershed. To meet the TMDL value, a reduction of over 50% of the aluminum and 20% iron load coming from these sources must be achieved. Also since aluminum and iron are present in the sediment coming from the watershed another way to reduce the aluminum loads is to reduce or at least maintain the current sediment loading to the streams. Fecal coliform reductions are needed mostly from agriculture lands and septic tanks.

9 References

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10 Appendix A: Hurricane Creek Watershed Modeling Report

Available in a separate document entitled the Hurricane Creek TMDL Appendices Report.

11 Appendix B: Biological Study

Available in a separate document entitled the Hurricane Creek TMDL Appendices Report.

12 Appendix C: Subwatershed Loadings

Available in a separate document entitled the Hurricane Creek TMDL Appendices Report.

13 Appendix D: Data Compilation

Available in a separate document entitled the Hurricane Creek TMDL Appendices Report.